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National Eutrophication Survey, Las Vegas, Nev.

Prepared for

Environmental Monitoring and Support Lab, Las Vegas, Nev.

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NATIONAL EUTROPHICATION SURVEY

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REPORT
ON
FORT SUPPLY RESERVOIR
WOODWARD COUNTY
OKLAHOMA

EPA REGION VI

WORKING PAPER No. 586

WITH THE COOPERATION OF THE

OKLAHOMA DEPARTMENT OF POLLUTION CONTROL

AND THE

OKLAHOMA NATIONAL GUARD

MARCH, 1977

REPORT ON FORT SUPPLY RESERVOIR

WOODWARD COUNTY, OKLAHOMA

EPA REGION VI

by

National Eutrophication Survey

Water and Land Monitoring Branch
Monitoring Applications Laboratory
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Eutrophication Survey Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 586

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

March 1977

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Oklahoma Department of Pollution Control for professional involvement, to the Oklahoma National Guard for conducting the tributary sampling phase of the Survey, and to those Oklahoma wastewater treatment plant operators who provided effluent samples and flow data.

Dr. Denver Talley, Director, Oklahoma Department of Pollution Control; the staff of the Oklahoma Water Resources Board; and the staff of the Oklahoma State Department of Health reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

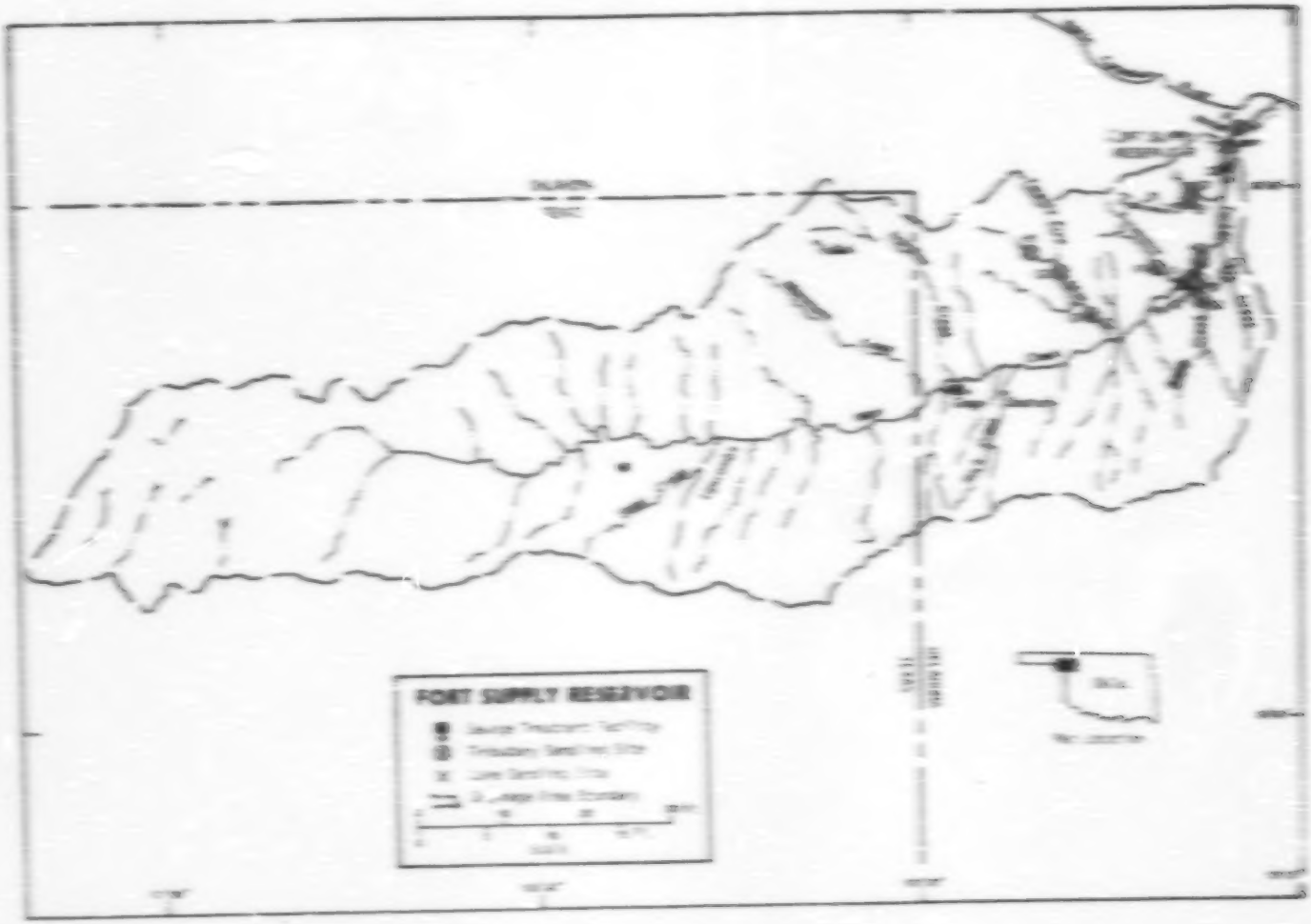
Major General John Coffey, Jr., the Adjutant General of Oklahoma, and Project Officers Colonel Curtis W. Milligan and Major James O. Haney, Jr., who directed the volunteer efforts of the Oklahoma National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF OKLAHOMA

LAKE NAME	COUNTY
Altus Reservoir	Greer, Kiowa
Arbuckle Lake	Murray
Lake Elsworth	Caddo, Comanche
Lake Eufaula	Haskell, McIntosh, Okmulgee, Pittsburg
Fort Cobb Reservoir	Caddo
Fort Supply Reservoir	Woodward
Foss Dam Reservoir	Custer
Lake Frances	Adair
Grand Lake O' The Cherokees	Mayes, Delaware, Craig, Ottowa
Lake Hefner	Oklahoma
Keystone Reservoir	Tulsa, Creek, Osage, Pawnee
Oologah Lake	Nowata, Rogers
Tenkiller Ferry Reservoir	Cherokee, Sequoyah
Lake Thunderbird	Cleveland
Wister Reservoir	Leflore


FORT SUPPLY RESERVOIR

REPORT ON FORT SUPPLY RESERVOIR, OKLAHOMA

STORET NO. 4006

I. CONCLUSIONS

A. Trophic Condition:*

On the basis of field observations and survey data, Fort Supply Reservoir is considered eutrophic, i.e., nutrient rich and highly productive. Whether such nutrient enrichment is to be considered beneficial or deleterious is determined by its actual or potential impact upon designated beneficial water uses of each lake.

Chlorophyll a levels in Fort Supply Reservoir ranged from 2.8 µg/l in the summer to 17.0 µg/l in the spring, with a mean of 9.7 µg/l. Potential for primary production, as measured by algal assay control yield, was low. Of the 16 Oklahoma lakes sampled in 1974, 5 had greater median total phosphorus, 10 had greater median inorganic nitrogen, and 9 had greater median orthophosphorus levels than Fort Supply Reservoir.

Field limnologists did not note any phytoplankton blooms or widespread macrophytes. However, low light penetration likely limits the productivity of this lake.

*See Appendix E.

B. Rate-Limiting Nutrient:

The ratios of inorganic nitrogen to orthophosphorus (N/P) suggest that nitrogen was the primary limiting nutrient on all three sampling occasions.

C. Nutrient Controllability:

1. Point sources -

Point sources were estimated to contribute 29.5% of the total phosphorus load to Fort Supply Reservoir during the sampling year. The city of Gage contributed 18.4%, and the city of Fargo contributed 11.1% of the total.

The calculated phosphorus annual loading of 0.44 g $P/m^2/yr$ is greater than Vollenweider's proposed "oligotrophic" loading (1975) but less than his "eutrophic" loading for lakes with such volume and retention time. Removal of phosphorus inputs from the two known point sources would not reduce loading to an "oligotrophic" level in the lake; however, it would further reduce potential for the occurrence of nuisance conditions since it appears that suspended material (as measured by Secchi disc) might be limiting primary productivity in Fort Supply Reservoir.

2. Nonpoint sources -

The mean annual load from nonpoint sources, including precipitation, accounted for 70.5% of the total reaching Fort Supply Reservoir. Wolf Creek contributed 51.3%, and ungaged tributaries were estimated to have contributed 4.5%.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake surface area and mean depth were provided by the Oklahoma Department of Pollution Control; maximum depth was provided by the Oklahoma Water Resources Board. Tributary flow data were provided by the Oklahoma District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Mean hydraulic retention time was obtained by dividing the lake volume by mean flow of the outlet. Precipitation values are estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 7.61 km^2.
2. Mean depth: 11.9 meters.
3. Maximum depth: 23.5 meters.
4. Volume: 90.559 x 10^6 m^3.
5. Mean hydraulic retention time: 582 days (1.6 yrs).

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area (km^2)	Mean Flow (m^3/sec)
A-2 Wolf Creek	3,689.7	2.19
B-1 Boggy Creek	130.6	0.09
D-1 Unnamed Creek	23.6	0.02
E-1 Eightmile Creek	33.9	0.02
Minor tributaries and immediate drainage -	76.1	0.06
Totals	3,861.9	2.31
2. Outlet - A-1 Wolf Creek	3,869.5	1.80

C. Precipitation:

1. Year of sampling: 58.7 cm.
2. Mean annual: 55.8 cm.

III. LAKE WATER QUALITY SUMMARY

Fort Supply Reservoir was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from one or more depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll *a* analysis and phytoplankton identification and enumeration. During the first and last visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 3.0 meters at Station 01 and 1.5 meters at Station 02. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll *a* determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/29/74	1. Kirchneriella	3,098
	2. Microcystis	634
	3. Oocystis	493
	4. Oscillatoria	422
	5. Chroomonas	352
	Other genera	1,197
	Total	6,196
06/10/74	1. Oocystis	682
	2. Chlamydomonas	243
	3. Chromulina	195
	4. Stephanodiscus	195
	5. Ankistrodesmus	146
	Other genera	243
	Total	1,704
10/24/74	1. Stephanodiscus	557
	2. Microcystis	381
	3. Chlamydomonas	352
	4. Oocystis	352
	5. Chroomonas	264
	Other genera	588
	Total	2,494

F. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
03/29/74	01	13.0
	02	17.0
06/10/74	01	4.3
	02	2.8
10/24/74	01	10.0
	02	10.5

C. Limiting Nutrient Study:

1. Discussion -

Significant nutrient losses occurred in algal assay samples prior to analysis. The assay results were therefore invalid and have not been included in this report.

The mean inorganic nitrogen to orthophosphorus (N/P) ratios in the lake data were 7/1, 10/1, and 9/1, respectively, in the spring, summer, and fall, suggesting nitrogen limitation at those times (a mean N/P ratio of 14/1 or greater generally reflects phosphorus limitation).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Oklahoma National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of April and May when two samples were collected. Sampling was begun in November 1974, and was completed in October 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Oklahoma District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries except Boggy Creek, B-1, were determined by using a modification of a USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for Boggy Creek, B-1, and unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual nutrient loads, in kg/km^2/yr, in Unnamed Creek and Eightmile Creek at Stations D-1 and E-1, and multiplying the means by the ZZ area in km^2.

Nutrient loads for the Gage and Fargo wastewater treatment plants were estimated at 1.134 kg P and 3.401 kg N/capita/yr.

A. Waste Sources:

1. Known municipal -

Name	Pop.* Served	Treatment*	Mean Flow ($m^3/d \times 10^3$)	Receiving Water
Gage	536	Stabilization pond	0.203**	Wolf Creek
Fargo	326	Stabilization pond	0.123**	Boggy Creek

2. Known industrial - None

*U.S.EPA, 1971, and/or plant operators.
**Estimated at 0.3785 m^3/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Wolf Creek	1,700	51.2
B-1 Boggy Creek	275	8.3
D-1 Unnamed Creek	75	0.7
E-1 Eightmile Creek	50	1.5
b. Minor tributaries and immediate drainage (nonpoint load) -	150	4.5
c. Known municipal STP's -		
Gage	610	18.4
Fargo	370	11.1
d. Septic tanks* -	5	0.2
e. Known industrial - None		
f. Direct precipitation** -	135	4.1
Totals	3,320	100.0
2. Output - A-1 Wolf Creek	2,670	
3. Net annual P accumulation -	650	

*Estimate based on 10 lakeshore residences.
**Estimated (see NES Working Paper No. 175).

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Wolf Creek	32,810	62.0
B-1 Boggy Creek	4,430	8.4
D-1 Unnamed Creek	855	1.6
E-1 Eightmile Creek	990	1.9
b. Minor tributaries and immediate drainage (nonpoint load) -	2,435	4.6
c. Known municipal STP's -		
Gage	1,825	3.5
Fargo	1,105	2.1
d. Septic tanks* -	105	0.2
e. Known industrial - None		
f. Direct precipitation** -	8,215	15.7
Totals	52,475	100.0
2. Output - A-1 Wolf Creek	60,715	
3. Net annual N export*** -	8,240	

*Estimate based on 10 lakeshore residences.
**Estimated (see NES Working Paper No. 175).
***Export due to unknown sources and/or sampling error.

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Wolf Creek	1	9
Doggy Creek	2	32
Unnamed Creek	1	36
Eightmile Creek	2	29

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P (mg/l)	Mean Total N (mg/l)
G-1 Turkey Creek	0.077	1.736
G-1 Twentymile Creek	0.092	1.071

F. Yearly Loadings:

In the following table, the existing phosphorus annual loading is compared to the relationship proposed by Vollenweider (1975). Essentially, his "eutrophic" loading is that at which the receiving waters would become eutrophic or remain eutrophic; his "oligotrophic" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A "mesotrophic" loading would be considered one between "eutrophic" and "oligotrophic".

Note that Vollenweider's model may not be applicable to water bodies with very short retention times or in which light penetration is severely restricted from high concentrations of suspended solids in the surface waters.

	Total Yearly Phosphorus Loading ($g/m^2/yr$)
Estimated loading for Fort Supply Reservoir	0.44
Vollenweider's "eutrophic" loading	0.54
Vollenweider's "oligotrophic" loading	0.27

V. LITERATURE REVIEWED

U.S. Environmental Protection Agency, 1971, "Inventory of Wastewater Treatment Facilities", EPA Publication No. OWP-1, Vol. 6, Office of Media Programs, Office of Water Programs, Washington, D.C.

U.S. Environmental Protection Agency, 1975, National Eutrophication Survey Methods 1973-1976, Working Paper No. 175, National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

Vollenweider, R. A., 1975, Input-Output Models With Special Reference to the Phosphorus Loading Concept in Limnology, Schweiz. Z. Hydrol. 37:53-84.

VI. APPENDICES

APPENDIX A
CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107 x 10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B
TRIBUTARY FLOW DATA

[redacted] MONTHLY FLOW INFORMATION FOR OKLAHOMA [redacted]

[redacted] FLOW SUPPLY REG.

TOTAL DRAINAGE AREA OF LAKE(S) =[redacted] SQ.MI.

STATION	SUB-DRAINAGE AREA(S) SQ MI	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = [redacted]
SUM OF SUB-DRAINAGE AREAS = [redacted]

TOTAL FLOW IN = [redacted]
TOTAL FLOW OUT = [redacted]

[redacted] MONTHLY FLOWS AND ASSOCIATED FLOWDOWNS

STATION	MONTH	YEAR	[redacted] FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
[redacted]	11	74	[redacted]	2	[redacted]				
	12	74	[redacted]	14	[redacted]				
	1	75	[redacted]	18	[redacted]				
	2	75	[redacted]	15	[redacted]				
	3	75	[redacted]	17	[redacted]				
	4	75	[redacted]	5	[redacted]	28	[redacted]		
	5	75	[redacted]	3	[redacted]	29	[redacted]		
	6	75	[redacted]	28	[redacted]				
	7	75	[redacted]	27	[redacted]				
	8	75	[redacted]	4	[redacted]				
	9	75	[redacted]	17	[redacted]				
	10	75	[redacted]	3	[redacted]				
[redacted]	11	74	[redacted]	2	[redacted]				
	12	74	[redacted]	14	[redacted]				
	1	75	[redacted]	18	[redacted]				
	2	75	[redacted]	15	[redacted]				
	3	75	[redacted]	17	[redacted]				
	4	75	[redacted]	5	[redacted]	29	[redacted]		
	5	75	[redacted]	3	[redacted]	29	[redacted]		
	6	75	[redacted]	28	[redacted]				
	7	75	[redacted]	27	[redacted]				
	8	75	[redacted]	4	[redacted]				
	9	75	[redacted]	17	[redacted]				
	10	75	[redacted]	3	[redacted]				

[redacted]

APPENDIX C

PHYSICAL AND CHEMICAL DATA

[illegible]

[illegible]

[illegible]

[illegible]						
[illegible]						
[illegible]						
[illegible]						

APPENDIX D

TRIBUTARY DATA

[illegible]

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	13	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	11	25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	10	20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	14	30		[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	10	07	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	01	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	04	25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	01	35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	12	25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	04	27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	01	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

[illegible]							
[illegible]							
[illegible]							
[illegible]							

[illegible]

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		[illegible]	N	TOTAL	[illegible]	
TO	DAY	FEET	MG/L	MG/L	MG/L	MG/L *	MG/L *
[illegible]							
75/11/02	09	48	0.439	0.438	0.333	0.025	0.025
75/12/14	12	15	0.445	0.454	0.348	0.005*	0.010*
75/01/07	11	37	0.441	0.431	0.346		0.010*
75/02/15	15	28	0.359	0.348	0.334	0.004*	0.010*
75/03/14	11	35	0.340	0.338	0.334	0.004*	0.016
75/04/05	13	19	0.411	0.358	0.340	0.005	0.011
75/04/19	12	14	0.435	0.458	0.355	0.005*	0.025
75/05/03	12	45	0.445	0.448	0.345	0.015	0.025
75/05/14	09	44	0.446	0.450	0.370	0.035	0.036
75/06/09	11	38	0.440	0.475	0.428	0.039	0.046
75/07/17	09	45	0.441	0.448	0.338	0.033	0.040
75/08/04	11	40	0.340	0.458	0.352	0.025	0.040
75/09/04	10	54	0.510	0.488	0.326	0.045	0.046
75/10/05	11	04	0.438	0.436	0.338	0.033	0.036

* VALUE KNOWN TO BE
LESS THAN INDICATED

[illegible]

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		[illegible]	[illegible]	TOTAL	[illegible]	
TO	DAY	FEET	[illegible]	[illegible]	[illegible]	[illegible] *	[illegible] *
[illegible]	08	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	17	17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	11	76	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	14	71	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	15	58	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	18	07	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	09	42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	16	19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	11	98	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	09	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	04	14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* [illegible]
[illegible]

[illegible]

[illegible]

[redacted]

DATE	TIME	DEPTH	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1974

STATE OF OKLAHOMA

[illegible] Data To Be Used In Rankings

Lake Name	[illegible] Total #	[illegible] Depth m	[illegible] Area sq.	[illegible] Volume	[illegible] Max Depth	[illegible] Elev. Above #
[illegible]	1,842	1,396	446,625	34,758	1,481	1,818
[illegible]	1,920	1,670	443,401	7,827	34,489	1,824
[illegible]	1,817	1,573	454,488	8,430	1,481	1,889
[illegible]	1,961	1,485	482,513	4,343	34,709	1,429
[illegible]	1,739	1,111	454,887	34,967	1,431	1,812
[illegible]	1,478	1,135	485,147	9,733	7,498	1,834
[illegible]	1,827	1,498	413,857	1,962	1,481	1,884
[illegible]	1,142	1,781	484,333	7,473	1,291	1,871
[illegible]	1,167	1,741	444,857	1,758	34,481	1,839
[illegible]	1,457	1,251	482,889	1,467	1,485	1,836
[illegible]	1,136	1,491	484,383	21,427	34,488	1,846
[illegible]	1,854	1,578	483,881	1,137	34,489	1,831
[illegible]	1,934	1,581	478,518	1,144	35,488	1,834
[illegible]	1,187	1,158	485,788	1,422	12,888	1,889
[illegible]	1,188		474,588	1,412	35,889	1,834
[illegible]	1,148	1,188	488,478	12,384	34,488	1,838

[illegible] OF LAKES with [illegible] VALUES [illegible] OF LAKES with [illegible] VALUES

[illegible]	LAKE NAME	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	40 (44	105 (151	47 (73	13 (21	86 (131	73 (113
[illegible]	[illegible]	100 (154	40 (134	93 (140	53 (80	33 (43	93 (140
[illegible]	[illegible]	40 (121	46 (133	46 (123	33 (40	60 (90	87 (276
[illegible]	[illegible]	39 (30	33 (54	27 (44	100 (254	47 (73	33 (43
[illegible]	[illegible]	73 (111	73 (111	67 (120	7 (13	60 (113	67 (100
[illegible]	[illegible]	29 (50	47 (140	0 (80	27 (43	100 (250	60 (90
[illegible]	[illegible]	93 (140	40 (120	60 (90	87 (133	60 (113	100 (250
[illegible]	[illegible]	9 (64	8 (82	7 (13	47 (73	93 (140	7 (13
[illegible]	[illegible]	13 (23	7 (13	44 (60	60 (93	20 (33	13 (30
[illegible]	[illegible]	47 (73	46 (93	67 (100	73 (113	67 (100	20 (30
[illegible]	[illegible]	7 (13	13 (23	13 (23	0 (80	13 (23	0 (80
[illegible]	[illegible]	40 (60	20 (33	20 (33	80 (125	33 (43	27 (43
[illegible]	[illegible]	67 (100	27 (44	100 (154	67 (100	3 (10	50 (73
[illegible]	[illegible]	87 (133	60 (93	53 (80	40 (60	53 (80	86 (133
[illegible]	[illegible]	27 (44	47 (73	33 (53	93 (140	3 (10	40 (60
[illegible]	[illegible]	53 (80	53 (83	73 (113	20 (33	33 (43	56 (73